

PLANT DENSITY AND FERTILIZATION MANOEUVERING TO ACHIEVE TARGETED RICE (*ORYZA SATIVA* L.) YIELD UNDER LATE SOWN CONDITIONS

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ABSTRACT

A field experiment was conducted on a sandy clay loam soil at college farm of Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad, Rajendranagar, Hyderabad, Telangana during the kharif seasons of 2014 and 2015 to study the rice varieties and combination of plant densities and fertilizers for achieving target yield under late sown condition. Among the varieties, MTU 1010 performed superior to Pradyumna and Rajendra in growth and yield attributes. Under late sown conditions the variety MTU 1010 cultivated with plant density of 15 cm × 10 cm, fertility levels of 195-86-90, N, P₂O₅ & K₂O can attain the target yield.

KEYWORDS: The Rice Varieties, Densities And Fertilizers

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INTRODUCTION

Rice (*Oryza sativa* (L.)) is one of the most important staple food crops in the world. However, more than 90 per cent of rice is consumed in Asia, where it is a staple food for a majority of the population, including the 560 million hungry people in the region (Mohanty, 2013). In Asia, more than two billion people are getting 60-70 per cent of their energy requirement from rice and its derived products. Among the rice growing countries, India has the largest area (42.27 m ha) and it is the second largest producer (105.24 m t) of rice next to China (144 m t). With an average productivity of 2.49 t ha⁻¹, though increasing marginally, but is still well below the world's average yield of 4.36 t ha⁻¹ (FAOSTAT Database, 2014). At the current population growth rate (1.5 %), the rice requirement of India by 2025 would be around 125 m t (Kumar *et al.*, 2009). The importance of continuing to develop new rice varieties to guarantee India's food security and support the region's economic development needs no special emphasis. Varieties play a vital role in maximizing of yield by improving the input use efficiency. The adverse effect of late transplanting can also be minimized by selecting suitable cultivar as magnitude of yield reduction varies with the rice cultivars. Plant population exerts a strong influence on the rice growth and grain yield, because of its competitive effects, both on the vegetative and reproductive development. Optimum plant spacing ensures plants to grow properly both in their aerial and underground parts through utilization of solar radiation and nutrients, therefore proper manipulation of planting density may lead to increase in the economic yield of transplanted rice. Targeted yield approach also provides scientific basis for balanced fertilization not only between the nutrients from the external sources but also from the external sources. The present study is proposed to study the suitable early duration rice varieties, plant population and fertilization for late sown conditions for

achieving the target yields.

MATERIAL AND METHODS

Field experiment was conducted during the *kharif* season of 2014 and 2015 at Agricultural College Farm, Rajendranagar, Hyderabad. The experimental site was geographically situated at an altitude of 542.6 m above mean sea level, on 17° 19' N latitude and 78° 24' E longitude. It comes under Southern Telangana zone of Telangana. The soil was sandy clay loam in texture, neutral in reaction (pH 7.2) with 0.49% of organic matter, with low available nitrogen (180.8 kg ha⁻¹), high available phosphorus (38.6 kg ha⁻¹) and potassium (312 kg ha⁻¹).

The experiments were laid out in a split plot design with three replications. Three varieties MTU 1010, Rajendra and Pradyumna as main plot treatments, three plant densities (P₁: 20 x 20 cm, P₂: 15 x 15 cm and P₃: 15 x 10 cm), three fertilizer levels (F₁: 111-32-45, F₂: 153-59-68 and F₃: 195-86-90) as sub plot treatments.

The fertilizer levels 111-32-45 kg NPK ha⁻¹, 153-59-68 kg NPK ha⁻¹ and 195-86-90 kg NPK ha⁻¹ were applied as 50 per cent N, full dose of P and 50 per cent K at the time of transplanting. Nitrogen was applied as per the treatments in 3 split doses as basal 50% and at active tillering and panicle initiation stages 25% each. The remaining half of potassium was applied at panicle initiation stage. A yield of 5.0, 6.0 and 7.0 t ha⁻¹ was taken as targeted yield. Based on the soil available nitrogen, phosphorus and potassium the required quantity of fertilizer to attain the targeted yield was calculated.

The fertilizer prescription equation to attain specific yield targets based on soil available nutrient level for the experimental field was as follows:

$$FN = 4.20 T - 0.55 SN$$

$$FP_2O_5 = 2.70 T - 2.67 SP$$

$$FK_2O = 2.22 T - 0.21 SK$$

Where, FN = Fertilizer nitrogen (kg ha⁻¹)

FP₂O₅ = Fertilizer phosphorus (kg ha⁻¹)

FK₂O = Fertilizer potassium (kg ha⁻¹)

T = Targeted yield (q ha⁻¹)

SN = Soil available nitrogen (kg ha⁻¹)

SP = Soil available phosphorus (kg ha⁻¹)

SK = Soil available potassium (kg ha⁻¹)

RESULTS AND DISCUSSIONS

Growth parameters *viz.*, plant height, number of tillers hill⁻¹, number of tillers m⁻², LAI, dry matter production were influenced by varieties in relation to combination of plant densities and fertilizer levels.

MTU 1010 produced taller plants at all the crop growth stages. Number of tillers hill⁻¹, number of tillers m⁻² significantly differed among the varieties and the variety MTU 1010 produced more number of tillers hill⁻¹, number of tillers m⁻² at all stages of crop growth compared to Rajendra and Pradyumna. Number of tillers hill⁻¹ and number of tillers

m⁻² produced were on par among the varieties Rajendra and Pradyumna. Significantly higher LAI was noticed in MTU 1010 compared to Rajendra and Pradyumna at all stages of crop growth and it was on par among Rajendra and Pradyumna. The difference in the growth characteristics of the varieties may be attributed to differences in genetic characteristics of the individual varieties. Similar results were reported by Rao and Moorthy (1997), Ramana *et al.*, 2007, Prasada Rao *et al.* (2011) and Malla Reddy *et al.* (2014).

Among combination of plant densities and fertilizer levels, LAI were higher in (T₉) P₃ (15 cm × 10 cm) in combination with F₃(195-86-90, N, P₂O₅ & K₂O) at all stages of crop growth. The number of tillers hill⁻¹ and the plant height were higher in under wider spacing P₁ (20x20 cm) in combination with increased fertility levels, F₃ (195-86-90 N, P₂O₅ & K₂O kg ha⁻¹) and the number of tillers m⁻² were higher in closer spacing P₃ (15 cm × 10 cm) in combination with F₃(195-86-90, N, P₂O₅ & K₂O). Similar results were reported by Yadav and Tripathi (2008), Nayak *et al.* (2003) and Navneet Aggarwal and Avtar Singh (2015).

Numbers of panicles m⁻² were higher with MTU 1010. It was on par among the varieties Pradyumna and Rajendra. Productive tillers were higher with P₃ (15 cm × 10 cm) in combination with F₃(195-86-90, N, P₂O₅ & K₂O). Productive tillers increased significantly with increasing fertility levels. The number of panicles per unit area are directly related to the plant density. This might be due to presence of more number of plants with closer spacing. Similar results were reported by Malla Reddy *et al.* (2014).

Significantly higher number of spikelets panicle⁻¹, number of filled spikelets panicle⁻¹ and test weight recorded with MTU 1010. The treatment P₁ (20 cm × 20 cm) in combination with F₃(195-86-90, N, P₂O₅ & K₂O) significantly recorded higher number of spikelets panicle⁻¹, number of filled spikelets panicle⁻¹ and test weight. The highest stature of these yield attributes under wider planting pattern may be attributed to lesser competition for growth resources and efficient translocation of assimilates from source to sink. Similar results were reported by Ramana *et al.* (2007).

The straw yield of MTU 1010 was significantly higher than that of Pradyumna which in turn recorded comparable straw yield with that of Rajendra. Similar results were reported by Malla Reddy *et al.* (2014). Significant higher straw yield was obtained in P₃ (15 cm × 10 cm) in combination with F₃(195-86-90, N, P₂O₅ & K₂O) and found on par with P₃ (15 cm × 10 cm) in combination with F₂(153-59-68, N, P₂O₅ & K₂O) compared to rest of the treatments. Significant effect on straw yield of varieties might be due to their significant influence on plant height and tiller number as the straw is the product of these two parameters. Similar results were reported by Chopra and Chopra (2004).

CONCLUSIONS

Significantly higher grain yield was registered by MTU 1010 as compared to varieties *i.e.*, Pradyumna and Rajendra. Straw yields trend was similar to that of grain yield. Maximum harvest index was observed with MTU 1010. The harvest index of the varieties Rajendra and Pradyumna were found on par. Similar results were reported by Ramana *et al.* (2007). Significantly higher grain yield was obtained with P₃ (15 cm × 10 cm) in combination with F₃(195-86-90, N, P₂O₅ & K₂O) which was at par with P₃ (15 cm × 10 cm) in combination with F₂(153-59-68, N, P₂O₅ & K₂O) with respect to rest of the treatments. The higher grain yield might be due to the fact that higher levels of NPK led to adequate supply of nutrients to the plant resulting in better growth which in turn led to better physiological process and movement of photosynthates to sink. The higher yield in closer plant geometry might be due to more panicle bearing shoots m⁻², number of spikelets panicle⁻¹, filled spikelets panicle⁻¹ and 1000-grain weight. Similar results were reported by Navneet Aggarwal and

Avtar Singh, 2015.

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APPENDICES

Table 1: Plant Height, LAI and Number of Tillers m⁻² at Different Stages of Crop Growth as Influenced by Rice Varieties in Relation to Combination of Plant Densities and Fertilizer Levels during *kharif* 2014 and 2015

Treatments	Plant Height (cm)		Leaf Area Index						Number of Tillers m ⁻²					
	At Harvest		30 DAT		45 DAT		60 DAT		30 DAT		45 DAT		60 DAT	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Main Treatments (Varieties)					lai				tillers					
V ₁ - MTU 1010	100.00	101.63	2.51	2.60	3.13	3.16	4.13	4.21	232.8	235.4	298.6	302.3	318.2	320.8
V ₂ -Rajendra	84.44	85.85	2.15	2.37	2.69	2.80	3.69	3.76	210.9	216.8	273.2	276.2	288.3	295.4
V ₃ - Pradyumna	87.59	89.04	2.22	2.41	2.81	2.84	3.73	3.84	217.7	220.6	283.5	287.1	298.1	303.4
SEm±	1.00	1.17	0.03	0.04	0.05	0.04	0.06	0.05	3.7	3.0	4.2	2.2	3.8	3.4
CD (0.05)	3.94	4.60	0.11	0.16	0.19	0.17	0.22	0.20	14.5	11.9	16.3	8.8	14.9	13.4
Sub Treatments (Combination of Plant Density and Fertilizer Levels)														
T ₁ -P ₁ F ₁	88.78	90.00	1.82	2.09	2.10	2.18	3.22	3.38	163.8	170.9	214.1	218.2	234.3	239.2
T ₂ -P ₁ F ₂	96.11	97.78	2.19	2.37	2.69	2.82	3.64	3.81	186.7	189.3	241.8	244.4	257.8	262.9
T ₃ -P ₁ F ₃	99.67	100.67	2.31	2.52	3.24	3.32	3.82	3.98	191.1	193.8	260.1	262.8	273.3	276.1
T ₄ -P ₂ F ₁	84.89	86.44	2.09	2.22	2.22	2.36	3.47	3.67	208.1	212.2	264.8	268.7	274.4	282.9
T ₅ -P ₂ F ₂	92.22	94.00	2.38	2.51	2.87	3.06	3.93	4.03	219.2	221.6	295.4	297.0	295.3	301.8
T ₆ -P ₂ F ₃	95.67	97.00	2.47	2.65	3.39	3.47	4.11	4.17	228.3	233.6	304.3	309.8	322.8	328.9
T ₇ -P ₃ F ₁	80.67	82.56	2.17	2.32	2.41	2.41	3.76	3.79	212.2	218.1	275.9	281.4	311.0	316.9
T ₈ -P ₃ F ₂	87.44	89.00	2.53	2.65	3.23	3.14	4.24	4.23	269.7	271.3	333.6	335.6	347.2	349.9
T ₉ -P ₃ F ₃	90.67	92.11	2.70	2.78	3.73	3.67	4.47	4.37	305.1	307.6	376.0	378.9	397.4	400.3
SEm±	1.18	1.17	0.05	0.05	0.07	0.06	0.07	0.07	6.5	7.5	7.8	6.0	8.0	8.4
CD (0.05)	3.36	3.33	0.14	0.13	0.19	0.18	0.20	0.20	18.6	21.3	22.3	17.1	22.6	24.0
Interaction														
SEm± (Vx T)	2.17	2.24	0.08	0.08	0.12	0.11	0.13	0.12	11.3	12.6	13.5	10.1	13.5	14.2
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SEm± (TxV)	2.04	2.03	0.08	0.08	0.12	0.11	0.12	0.12	11.3	13.0	13.6	10.4	13.8	14.6
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Yield Attributes as Influenced by Varieties in Relation to Combination of Planting Densities and Fertilizer Levels during *kharif* 2014 and 2015

Treatments	Number of Panicles (M ⁻²)		1000 Grain Weight (G)		Spikelets Panicle ⁻¹		Filled Spikelets Panicle ⁻¹		Grain Yield (Kg Ha ⁻¹)		Straw Yield (Kg Ha ⁻¹)		Harvest Index (%)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Main Treatments (Varieties)														
V ₁ - MTU 1010	272.9	277.7	23.91	24.11	113.0	115.8	104.7	109.3	5891	6113	6756	7358	45.15	44.70
V ₂ -Rajendra	255.4	260.4	18.72	18.81	105.6	107.0	94.9	98.1	4885	5022	5495	6125	44.98	44.25
V ₃ - Pradyumna	262.6	266.8	19.06	19.19	109.9	110.9	100.0	102.5	5195	5351	5870	6531	44.98	44.26
SEm±	2.71	2.69	0.23	0.24	1.35	1.22	1.10	1.18	57	63	74	75	0.05	0.03
CD (0.05)	10.66	10.57	0.91	0.96	5.32	4.78	4.32	4.65	223	247	291	295	0.19	0.11
Sub Treatments (Combination of Planting Density and Fertilizer Levels)														
T ₁ -P ₁ F ₁	214.4	213.2	20.28	20.59	102.3	105.6	92.9	97.4	4092	4239	5052	5189	43.77	43.99
T ₂ -P ₁ F ₂	238.8	233.2	21.07	21.14	115.6	116.8	106.4	109.0	4499	4660	5468	5617	44.24	44.47
T ₃ -P ₁ F ₃	246.9	240.8	21.33	21.26	120.8	122.2	111.6	115.6	4685	4817	5659	5812	44.43	44.48
T ₄ -P ₂ F ₁	248.4	256.4	19.80	20.08	99.9	102.1	90.1	93.6	4986	5141	6147	6315	44.00	44.09
T ₅ -P ₂ F ₂	272.2	274.7	20.71	20.92	111.6	113.4	102.2	105.3	5378	5571	6568	6748	44.27	44.49
T ₆ -P ₂ F ₃	278.4	281.2	20.92	21.10	115.7	117.8	106.6	110.2	5613	5814	6849	7037	44.33	44.55
T ₇ -P ₃ F ₁	271.6	288.9	19.56	19.63	99.7	100.8	89.2	91.8	5826	6034	7148	7344	44.22	44.43
T ₈ -P ₃ F ₂	297.8	310.6	20.59	20.77	108.2	109.3	98.0	101.2	6341	6532	7715	7927	44.46	44.54
T ₉ -P ₃ F ₃	304.3	315.6	20.80	20.82	111.9	113.2	101.9	105.4	6494	6647	7836	8052	44.67	44.59
SEm±	4.40	4.57	0.11	0.11	1.86	1.87	1.83	1.74	78	78	105	109	0.12	0.11
CD (0.05)	12.52	12.99	0.31	0.32	5.28	5.32	5.21	4.96	222	222	300	311	0.34	0.30
Interaction														
SEm± (Vx T)	7.69	7.93	0.29	0.31	3.32	3.29	3.19	3.08	139	142	188	194	0.20	0.18
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SEm± (TxV)	7.63	7.91	0.19	0.20	3.22	3.24	3.17	3.02	135	135	183	190	0.21	0.18
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

